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3E. DATA FROM AGARD REPORT 702

INTRODUCTION

In the late seventies a need was perceived for standard comparison cases and experimental data to aid the comparison and validation of the theoretical methods then emerging for unsteady aerodynamics. A Working Group of the AGARD Structures and Materials panel chose a set of 2-D and 3-D configurations and for each configuration defined a set of test cases, including a prioity subset, to be used for comparisons. These test cases were fully identified in ref.1 and 2. The chosen configurations were known as the AGARD Aeroelastic Configurations and the chosen cases were denoted as Computational Test (CT) cases. Some of the CT cases were entirely theoretical while others were also the subject of unsteady measurements.

The next step undertaken to aid the methods development was to produce an experimental data compendium (AGARD Report 702, ref.3) which was conceived with the idea of bringing together the experimental data most important for the comparisons. The report was followed by an Addendum, ref.4, which introduced two additional 3-D experiments. These reports established an admirable common base for providing experimntal data and their value has been demonstrated by the repeated use of the test cases for the entire period since publication. The report has served as a model for the present new compendium of experimental data.

It was decided that some of the data cases in the original Report 702 should be reproduced in this document in order to provide more complete coverage in this report with the additional bonus of making available the original data in electronic form to facilitate its continued use to validate calculations.

The data sets contained in ref.3 and 4 were:

Set 1	NLR	NACA 64A006 Oscillating Flap
Set 2	NASA Ames	NACA 64A010 Oscillatory Pitching
Set 3	ARA	NACA 0012 Oscillatory and Transient Pitching
Set 4	NLR	NLR 7301 Supercritical Airfoil Oscillatory Pitching and Oscillatory Flap
Set 5	NLR	NLR 7301 Supercritical airfoil Oscillatory Pitching
Set 6	RAE	RAE Wing A, Oscillating Flap
Set 7	RAE/NLR/ONERA	NORA model, Oscillation about a Swept Axis
Set 8	MBB/ONERA	ZKP wing, Oscillating Aileron
Set 9	NLR	LANN wing, Pitching Oscillation

The characterisitics of the nine experiments are summarised in the following two tables giving a guide to the characteristics of the motion in each experiment and the types of data measured.

Set	1	2	3	4	5	6	7	8	9
wing or section	NACA 64A006 symmetric 6%	NACA 64A010 symmetric 10%	NACA 0012 symmetric 12%	NLR 7301 supercritical 16.5%	NLR 7301 supercritical 16.5%	Wing Aspect ratio 6 LE sweep 36°	NORA aspect ratio 2 LE sweep 50°	ZKP, aspect ratio 9, LE sweep 30°	LANN, aspect ratio 8, LE sweep 28°
form of motion	flap 25%c	pitch about 25%c	pitch about 25%c	pitch about 40%c and flap 25%c	pitch about 40%c	mid-span flap, 30%c	"pitch" about swept axis	outboard flap, 22.6%c	pitch
Maximum amplitude	1°	2°	9.5° oscill ramp to 30°	1.5° pitch, 2° flap	2°	2°	1°	2°	1°
Mach range	0.5 - 1	0.5 - 0.85	0.3 - 0.87	0.5 - 0.8	0.4 - 0.85	0.4 - 0.95	0.6 - 1.1	0.5 - 0.83	0.6 - 0.95
mean chord (m)	0.18	0.5	0.1	0.18	0.5	0.16	0.44	0.95	0.268
Frequency range Hz	0 - 120	0 - 60	0 - 60	0 - 80 pitch 0 - 200 flap	0 - 60	0 - 90	0 - 60	6 - 21	0 - 72
Maximum reduced frequency	0.4	0.3	0.25	0.26 pitch 0.65 flap	0.3	0.26	0.31	0.3	0.15

Set	1	2	3	4	5	6	7	8	9
Steady pressures for mean conditions	Y	Y	N	Y	Y	Y	Y	Y	Y
Steady pressures for small changes from the mean conditions	Y	N	N	Y	N	N	N	Y	Y
Quasi-steady pressures	N	N	Y	N	N	Y	Y	Y	N
Unsteady pressures	Y	Y	Y	Y	Y	Y	Y	Y	Y
Steady section forces for the mean conditions by integration of pressures	Y	Y	N	Y	Y	N	Y	Y	Y
Steady section forces for small changes from the mean conditions by integration	Y	N	N	Y	N	N	N	N	Y
Quasi-steady section forces by integration	N	N	Y	Y	N	N	Y	Y	N
Unsteady section forces by integration	Y	Y	Y	Y	N	N	Y	Y	Y
Measurement of actual motion at points of the model	Y	Y	N	Y	Y	N	Y	Y	Y
Observation or measurement of boundary layer properties	N	Y	N	N	Y	Y	N	N	N
Visualisation of surface flow	N	Y	N	N	Y	Y	N	N	N
Visualisation of shock wave movements	Y	N	N	Y	N	N	N	N	N

The selection of sets for reproduction in this chapter was based on considerations of the form of data and the feasibility of transferring the data to electronic media, and also on the type of experiment, particularly the uniqueness of the data beside the new data presented in this report. The sets selected are:

Set 1	NLR	NACA 64A006 Oscillating Flap
Set 3	ARA	NACA 0012 Oscillatory and Transient Pitching
Set 4	NLR	NLR 7301 Supercritical Airfoil Oscillatory Pitching and Oscillatory Flap
Set 8	MBB/ONERA	ZKP wing, Oscillating Aileron

PRESENTATION OF DATA

The data for Sets 1, 4 and 8 are supplied on ASCII files in a common format. For each Set the main test data is on a single file with the format defined below. A FORTRAN program (RUNAD.FOR) is provided which demonstrates the extraction of the data and. The program includes a sample main segment which displays the data of a specific run or creates a file containing formatted tables of all the data in the Set, via a call to subroutine SELUNAD. This subroutine may be employed in a user's code to extract the data for a single table or to serve as a model for other data extraction codes.

SELUNAD subroutine

A description of the subroutine call and arguments follows:

```
C
      SUBROUTINE SELUNAD(NCH,FILNAM,KRUN,MAXP,MAXSEC,MAXCPV,VMACH,FREQ
     1,AERFM,AERFA,FLAPM,FLAPA,NSEC,LSEC,RTEXT,ICPST,ICPUS,IMACH,ICLM
     2,CL,CM,CP,VMST,XT,YT,NMT)
C
C-- This routine reads and selects data from a UNAD standardised unsteady aero
C   data file and returns the available data
C-- Arguments are as defined below:
C   Input values
C         NCH       FORTRAN channel number to be used for reading the input file
C         FILNAM    The name of the required input file
C         KRUN      Specifies the required run number
C         MAXP      The declared dimension in the calling routine for number of
C                   transducer locations in one section for one subclass of data
C                   unsteady
C         MAXSEC    The declared dimension in the calling routine for the number
C                   of sections in this data
```

```
C         MAXCPV   The declared dimension in the calling routine for the number
C                  of CP values,  a minimum of 3 is required for oscillatory
C                  data, number of time values for time history
C   Returned values
C         VMACH    Mach number for this run
C         FREQ     Oscillatory frequency for this run (Hz)
C         AERFM    Mean wing/aerofoil incidence for this run (deg)
C         AERFA    Wing/aerofoil incidence oscillation amplitude for run (deg)
C         FLAPM    Mean flap angle for this run (deg)
C         FLAPA    Flap angle oscillation amplitude for this run (deg)
C         NSEC     The number of sections in this data
C         LSEC(is) Integer array giving identifier number of each section
C         RTEXT    Character string giving optional description of this run
C The following four quantities are integers which return with the value of
C zero if the corresponding data is not given:
C         ICPST    Set positive if steady CP values given for this run
C         ICPUS    Set positive if oscillatory unsteady CP values given
C         IMACH    Set positive if local Mach number values are given
C         ICLM     Set positive if local CL,CM values given for sections
C
C The following array quantities are defined using specific variables :
C   i   for transducer location (1 to NMT)
C   j   as surface indicator (=1 upper surface, =2 lower surface)
C   is  section number (1 to NSEC)
C   it  quantity type (=1 steady, =2 unsteady)
C   k   variable quantity =1 for steady values, =2 for oscillatory real,
C                         =3 oscillatory imag
C
C         CL(i,k)        Lift coefficients for each section
C         CM(i,k)        Pitching moment coefficient for each section
C         CP(i,k,j,is)   Pressure coefficients
C         VMST(i,j,is)   Local Mach numbers
C         XT(i,it,j,is)  Chordwise locations of transducers, non-dimensionalised
C                        by dividing by local chord
C         YT(i,it,j,is)  Spanwise locations of transducers, non-dimensionalised
C                        by dividing by semi-span
C         NMT(it,j,is)   Numbers of locations of transducers in specific sections
C
      REAL CL(3,MAXSEC),CM(3,MAXSEC), CP(MAXP,MAXCPV,2,MAXSEC)
     1,VMST(MAXP,2,MAXSEC), XT(MAXP,2,2,MAXSEC), YT(MAXP,2,2,MAXSEC)
      INTEGER NMT(2,2,MAXSEC), LSEC(MAXSEC)
      CHARACTER *80 FILNAM, TITLE, RTEXT
C
```

UNAD data format

The UNAD data files are ASCII with free formatting within the structure of heading information followed by data with type determined by a control number. Each test is refered to by a run number, which in the pplication to the AGARD R702 data sets is generally the number of the corresponding tablein that report.

The first line of the file contains a text record of up to 80 characters describing the data on the file.

The second line of the file contains the lowest and highest run numbers for tests included on the file.

The remaining data on the file is in segments introduced by a control number (denoted here by NCON) on a single line at the start of the segment.

NCON=0 Marks the end of data on the file

NCON=1 This segment defines the data quantities included on this file. These integers are set zero if data is not included or positive if data is included for this run:

- `ICPST` if steady CP values given
- `ICPUS` if oscillatory unsteady CP values given as real & imag parts
- `IMACH` if local Mach number values are given
- `ICLM` if local CL, CM values given for each section

NCON=2 This segment defines transducer locations. Data is grourped into sections and each section may include locations for steady and unsteady transducers on upper and lower surfaces:
`NSEC` number of sections or groups of data on first record
For each of the NSEC sections the following data, starting on a new record:
First record contains an integer section identifier. Note that this does not appear if NSEC=1

The next record contains the number of transducers (NMT) of a particular type followed (if NMT>0) on the subsequent records by pairs of values giving the X and Y coordinates of the transducers. The chordwise location X is non-dimensionalised by local chord and the spanwise location Y by the semi-span. These data (number followed by X,Y array) are repeated in order for upper surface steady, upper surface unsteady, lower surface steady, lower surface unsteady.

NCON=3 This segment defines run data. First parametric values are given:

`IRUN`	integer run number
`VMACH`	Mach number for this run
`FREQ`	Frequency of oscillation (Hz)
`AERFM`	Mean wing/aerofoil flap angle for this run (deg)
`AERFA`	Wing/aerofoil oscillation amplitude for this run (deg)
`FLAPM`	Mean flap angle for this run (deg)
`FLAPA`	Flap oscillation amplitude for this run (deg)
`ITEXT`	Integer, if positive indicates that a run description text is given on the next record
`RTEXT`	Run descriptive text (if any, as specified by ITEXT). A single record up to 80 characters.

The data for this run is then given in the same order as for the transducer locations. For each steady set of data points are all CPST followed by all MACH if both are given for the current surface, thus data quantities if all appear are:

steady upper surface CP
steady upper surface local Mach number
unsteady upper surface CP real part
unsteady upper surface CP imaginary part
steady lower surface CP
steady lower surface local Mach number
unsteady lower surface CP real part
unsteady lower surface CP imaginary part
CL steady, CM steady
CL oscillatory real, imag, CM oscillatory real, imag

List of references

1 S R Bland. AGARD two-dimensional aeroelastic configurations. AGARD AR 156, August 1979.

2 S R Bland. AGARD three-dimensional aeroelastic configurations. AGARD AR 167, March 1982.

3 Compendium of unsteady aerodynamic measurements. AGARD Report No.702. August 1982.

4 Compendium of unsteady aerodynamic measurements. AGARD Report No.702 Addendum 1. May 1985.

3E1. NACA 64A006 OSCILLATING FLAP

R.J. Zwaan, NLR

INTRODUCTION

The wind tunnel model which had a NACA 64A006 airfoil section, was fitted with a trailing-edge flap of 25 per cent of the chord. The maximum thickness of this symmetrical airfoil is 6 per cent and is located at about 28 per cent of the chord. During the test the main surface was clamped at the wind tunnel side walls, whereas the flap could be driven in a harmonic motion about an axis at 75 per cent of the chord. The flap had no aerodynamic balance.

In the set of two-dimensional aeroelastic configurations this airfoil represents the category of small thickness and conventional airfoils (roof-top type). The characteristics are illustrated in figure 1, presenting the development of the steady and unsteady pressure distributions with Mach number for a given frequency. Passing the critical Mach number, $M^* \approx 0.85$, the measured unsteady pressure distributions start to deviate from the calculated distributions under the influence of shocks at both sides. The calculated results are based on lifting surface theory.

Lift and moment coefficients are given in figure 2 for a frequency of 120 Hz. An at least qualitative agreement exists between experiment and theory up to $M \approx 0.85$. Results are also given for $k = 0$, see figure 3. The differences between experiment and theory are appreciably larger now, which can be ascribed partly to tunnel wall interference.

LIST OF SYMBOLS AND DEFINITIONS

α_m	ALPHA	mean wing incidence, deg
δ_0	C	flap amplitude, deg; see note below
c		airfoil chord
C_p	CP	steady mean pressure coefficient
	DCP	oscillatory pressure coefficient ($k \neq 0$), tabulated as REal, IMaginary, MODulus and ARGument, equivalent to $-C_p / \delta_0$, in which $C_p / \delta_0 = (C'_p / \delta_0) + i\,(C''_p / \delta_0)$. RE, IM, MOD, in rad^{-1}, ARG in deg. If k=0, then $DCP = -[C_p(+\delta_0) - C_p(-\delta_0)] / 2\delta_0$
δ_m	DELTA	mean flap angle, deg
f	F	frequency, Hz
k	K	reduced frequency, $k = \pi fc/V$
k_c	KC	oscillatory wing lift coefficient, $C_L/\pi\delta_0$, rad^{-1}
M_L	M	mean local Mach number
m_c	MC	oscillatory wing pitching moment coefficient (about 0.25c)', $-2C_m/\pi\delta_0$, rad^{-1}
n_c	NC	oscillatory flap hinge moment coefficient, $-2C_h/\pi\delta_0$, rad^{-1}
p_t	PO	total pressure, Pa
q	Q	dynamic pressure, Pa
	RC	oscillatory flap lift coefficient, $C_{Lf}/\pi\delta$, rad^{-1}
R_e	RE	Reynolds number based on wing chord
x		chordwise coordinate of the airfoil (% chord)
z		vertical coordinate of the airfoil (% chord)
+ suffix		upper side
- suffix		lower side

Note: The oscillatory motion is defined as $\delta = \delta_0 \sin(\omega t)$. The equation for an oscillatory pressure reads: $p(t) = p_m + p' \sin(\omega t) + p'' \cos(\omega t)$ + etc. Similar expressions hold for the aerodynamic coefficients.

PRESENTATION OF DATA

The data which were presented in tables 5 to 18 of Report 702 for this test are supplied here as a single ASCII data file SET1.UND in RUNAD format as defined in the introduction to chapter 3. The table numbers are used as the "run numbers" for data selection by the program RUNAD. Tables 5 and 6 are reproduced here as samples with key parameters from the remaining tables. Note that for the zero-frequency tests the values of CL, CM and CP given as "steady" apply for the airfoil with undeflected flap and the values given as "real parts of oscillatory" CL and CM and the DCP values apply to the deflected flap configuration.

FORMULARY

1 General Description of model

1.1	Designation	NACA 64A006
1.2	Type	Roof top. 6 % thick symmetrical airfoil
1.3	Derivation	See Table 1 for geometry
1.4	Additional remarks	-
1.5	References	1

2 Model Geometry

2.1	Planform	Two-dimensional airfoil
2.2	Aspect ratio	NA
2.3	Leading edge sweep	0
2.4	Trailing edge sweep	0
2.5	Taper ratio	0
2.6	Twist	0
2.7	Wing centreline chord	0.18m
2.8	Semi-span of model	0.42m
2.9	Area of planform	0.0756 m^2
2.10	Location of reference sections and definition of profiles	See table 2
2.11	Lofting procedure between reference sections	NA
2.12	Form of wing-body junction	NA
2.13	Form of wing tip	NA
2.14	Control surface details	Flap hinge axis at 0.75c, gap width 0.1mm
2.15	Additional remarks	-
2.16	References	-

3 Wind Tunnel

3.1	Designation	NLR Pilot Tunnel
3.2	Type of tunnel	Continuous closed circuit
3.3	Test section dimensions	Rectangular, see fig. 4. height 0.55 m, width 0.42 m
3.4	Type of roof and floor	10 % slotted top and bottom walls, separate top and bottom plenums
3.5	Type of side walls	Solid side walls
3.6	Ventilation geometry	See fig. 4
3.7	Thickness of side wall boundary layer	Thickness 10 % of test section semi-width, no special treatment
3.8	Thickness of boundary layers at roof and floor	Not measured; probably comparable'with side wall boundary layers

3.9	Method of measuring Mach number	Derived from static pressure measured upstream of model and from total pressure measured in settling chamber
3.10	Flow angularity	-
3.11	Uniformity of Mach number over test section	See fig. 5.
3.12	Sources and levels of noise or turbulence in empty tunnel	See fig. 6 for turbulence/noise levels
3.13	Tunnel resonances	No evidence
3.14	Additional remarks	For two-dimesnionality of the flow see ref. 3
3.15	References on tunnel	2

4 Model motion

4.1	General description	Flap oscillation
4.2	Natural frequencies and normal modes of model and support system	No interference with natural vibration modes

5 Test Conditions

5.1	Model chord/tunnel width	0.435
5.2	Model chord/tunnel height	0.323
5.3	Blockage	-
5.4	Position of model in tunnel	-
5.5	Range of Mach numbers	M = 0.5 to 1.0
5.6	Range of tunnel total pressure	Atmospheric
5.7	Range of tunnel total temperature	313 ± 1 K
5.8	Range of model steady or mean incidence	α_m :-4 ° to 0 °; δ_m: -3 ° to 3 °
5.9	Definition of model incidence	Zero incidence defined by matching upper and lower static pressure distribution (applicable because of airfoil symmetry)
5.10	Position of transition, if free	NA
5.11	Position and type of trip, if transition fixed	2.5 mm strip of carborundum garins at 0.1c
5.12	Flow instabilities during tests	No evidence
5.13	Changes to mean shape of model due to steady aerodynamic load	-
5.14	Additional remarks	-
5.15	References describing tests	4

6 Measurements and Observations

6.1	Steady pressures for the mean conditions	Y
6.2	Steady pressures for small changes from the mean conditions	Y
6.3	Quasi-steady pressures	N
6.4	Unsteady pressures	Y
6.5	Steady section forces for the mean conditions by integration of pressures	Y
6.6	Steady section forces for small changes from the mean conditions by integration	Y
6.7	Quasi-steady section forces by integration	N
6.8	Unsteady section forces by integration	Y
6.9	Measurement of actual motion at points of model	Y
6.10	Observation or measurement of boundary	N

	layer properties	
6.11	Visualisation of surface flow	N
6.12	Visualisation of shock wave movements	Y
6.13	Aditional remarks	N

7 Instrumentation

7.1	Steady pressure	
	7.1.1 Position of orifices spanwise and chordwise	See 7.2.1
	7.1.2 Type of measuring system	See 7.2.3
7.2	Unsteady pressure	
	7.2.1 Position of orifices spanwise and chordwise	See figures 7 and 8
	7.2.2 Diameter of orifices	0.8mm
	7.2.3 Type of measuring system	38 pressure tubes + 6 in situ pressure transducers
	7.2.4 Type of transducers	±2.5 psi and ±5 Psi Statham differential pressure transducers, and ±5 psi Kulite miniature pressure transducers
	7.2.5 Principle and accuracy of calibration	Calibration uses transfer functions of pressure tubes. see Ref. 4; for accuracy see 9.10
7.3	Model motion	
	7.3.1 Method of measuring motion reference coordinate	See fig. 7
	7.3.2 Method of determining spatial mode of motion	
	7.3.3 Accuracy of measured motion	See 9.10
7.4	Processing of unsteady measurements	
	7.4.1 Method of acquiring and processing measurements	See fig. 9
	7.4.2 Type of analysis	Signal analysis of TFA over 20 cycles for f = 30 Hz and 60 cycles for f = 120 Hz
	7.4.3 Unsteady pressure quantities obtained and accuracies achieved	Fundamental harmonies; for accuracy see 9.10
	7.4.4 Method of integration to obtain forces	Trapezoidal rule
7.5	Additional remarks	-
7.6	References on techniques	4 and 5

8 Data presentation

8.1	Test cases for which data could be made available	Table 3
8.2	Test cases for which data are included in this document	Table 4
8.3	Steady pressures	Mean pressures in tables 5 to 18
8.4	Quasi-steady or steady perturbation pressures	Steady pressure derivatives in Tables 5, 8, 11, 14 and 17
8.5	Unsteady pressures	Tables 6, 7, 9, 10, 12, 13, 15, 16 and 18
8.6	Steady forces or moments	-
8.7	Quasi-steady or unsteady perturbation forces	See 8.4
8.8	Unsteady forces and moments	See 8.5
8.9	Other forms in which data could be made available	-
8.10	Reference giving other representations of data	6

9 Comments on data

9.1	Accuracy	
	9.1.1 Mach number	±0.002
	9.1.2 Steady incidence	±0.02°
	9.1.3 Reduced frequency	±0.0005
	9.1.4 Steady pressure coefficients	Not known
	9.1.5 Steady pressure derivatives	Not known
	9.1.6 Unsteady pressure coefficients	Not known
9.2	Sensitivity to small changes of parameter	No evidence
9.3	Non-linearities	Part of analysis of experimental results, see ref. 4
9.4	Influence of tunnel total pressure	-
9.5	Effects on data of uncertainty, or variation, in mode of model motion	
9.6	Wall interference corrections	No corrections included
9.7	Other relevant tests on same model	None
9.8	Relevant tests on other models of nominally the same shapes	Unknown
9.9	Any remarks relevant to comparison between experiment and theory	Comparisons of experiment and theory including various calculation methods are given in ref. 4
9.10	Additional remarks	No systematic investigations of separate accuracies have been performed; accuracy of lift and moment coefficients is estimated to be 5 to 10 per cent in maginutde and 3 to 6 degrees in phase angle
9.11	References on discussion of data	4 and 7

10 Personal contact for further information

Evert G M Geurts
Department of Aerodynamics Engineering and Aeroelasticity
Phone: +31 20 5113455
Fax: +31 20 5113210
Email: geurts@nlr.nl

National Aerospace Laboratory NLR
Anthony Fokkerweg 2 P.O. Box 90502
NL 1059 CM Amsterdam NL 1006 BM Amsterdam
The Netherlands The Netherlands
Phone: +31 20 5113113
Fax: +31 20 5113210
Website: http://www.nlr.nl

11 List of references

1 I.H. Abbott, A.E. von Doenhoff. Theory of wing sections. Dover Publications, Inc., New York, 1959

2 J. Zwaaneveld. Principal data of the NLL Pilot Tunnel NLL Report MP 185, 1959

3 H.A. Dambrink. Investigation of the 2-dimensionality of the flow around a profile in the NLR 0.55x0.42 m2 transonic wind tunnel. NLR Memorandum AC-72-018, 1972

4 H. Tijdeman. Investigations of the transonic flow around oscillating airfoils. NLR TR 77090 U, 1977

5 P.H. Fuykschot L.J.M. Joosten. DYDRA - Data logger for dynamic measurements. NLR MP 69012 U, 1969

6 H. Tijdeman, P. Schippers. Results of pressure measurements on an airfoil with oscillating flap in two-dimensional high subsonic and transonic flow (zero incidence and zero mean flap position). NLR TR 73078 U, 1973

7 R. Houwink. Some remarks on boundary layer effects on unsteady airloads. AGARD-CP-296, 1981

8 S. R. Bland. AGARD Two-dimensional aeroelastic configurations. AGARD-AR-156, 1979

Table 1 Contour data of the NACA 64A006 airfoil

x (%c)	z (%c)	x (%c)	z (%c)	x (%c)	z (%c)
0	0	20	2.557	65	2.188
0.5	0.485	25	2.757	70	1.907
0.75	0.585	30	2.896	75	1.602
1.25	0.739	35	2.977	80	1.285
2.5	1.016	40	2.999	85	0.967
5.0	1.399	45	2.945	90	0.649
7.5	1.684	50	2.825	95	0.331
10	1.919	55	2.653	100	0.013
15	2.283	60	2.438		

L.E. radius: 0.246 %c

Table 2 Actual Contour data of the NACA 64A006 airfoil model

Actual contour data of the NACA 64A006 airfoil (measures per cent of chord)

x	z_{upper}	z_{lower}	x	z_{upper}	z_{lower}
1.25	0.724	-0.742	50.00	2.822	-2.819
2.50	1.025	-1.025	55.00	2.655	-2.642
5.00	1.405	-1.405	60.00	2.430	-2.425
7.50	1.686	-1.686	65.00	2.194	-2.169
10.00	1.919	-1.922	70.00	1.908	-1.894
15.00	2.283	-2.283	75.00	-	-
20.00	2.558	-2.555	80.00	1.310	-1.310
25.00	2.758	-2.758	85.00	0.989	-0.989
30.00	2.894	-2.889	90.00	0.668	-0.668
35.00	2.975	-2.969	95.00	0.346	-0.346
40.00	2.991	-2.989	100.00	0.027	-0.027
45.00	2.942	-2.936			

Table 3 Test program for the NACA 64A006 airfoil with flap

Amplitude of oscillation: $\delta_0 = 1$ °

Test Condition	Freq Hz	Mach number 0.50	0.75	0.775	0.80	0.825	0.85	0.875	0.90	0.92	0.94	0.96	0.98	1.00
	0	x	x		x	x	x	x	x	x	x	x	x	x
$\alpha_m = 0°$	10	x				x	x	x	x			x		
	20	x						x						
$\delta_m = 0°$	30	x			x	x	x	x	x			x		
	90	x				x	x	x	x			x		
	120	x	x	x	x	x	x	x	x	x	x	x	x	x
$\alpha_m = 0°$	0	x	x		x	x	x	x	x	x	x	x	x	x
	30	x				x	x	x		x				
$\delta_m = 3°$	120	x	x	x	x	x	x	x		x	x	x		
$\alpha_m = -2°$	0	x	x		x	x	x	x	x	x	x	x		
	30	x				x	x	x	x					
$\delta_m = 0°$	120	x	x	x	x	x	x	x	x	x	x			
$\alpha_m = -2°$	0	x	x	x	x	x	x	x	x	x	x	x		
	30	x				x	x	x						
$\delta_m = -3°$	120	x	x	x	x	x	x	x						
$\alpha_m = -4°$	0	x	x	x	x	x	x	x	x	x				
	10	x						x						
$\delta_m = 0°$	30	x					x	x						
	120	x	x	x	x	x	x	x	x	x				

Table 4 Test cases for the NACA 64A006 airfoil with flap included in Data Set 1

	CT case				Data set 1						
Flow	No	M	δ_0	k	Run No	M	δ_0	δ_m	k	Re*10^{-6}	Table
Subsonic	z1	0.800	1.5	0	-	0.800	1.5	0	0	2.34	5
	1	0.800	1.0	0.064	40904	0.794	1.09	0.15	0.064	2.32	6
	2	0.800	1.0	0.253	40807	0.804	1.11	0.00	0.253	2.35	7
	z2	0.825	1.5	0	-	0.825	1.5	0	0	2.36	8
	3	0.825	1.0	0.062	40905	0.824	1.09	0.15	0.062	2.36	9
	4	0.825	2.0	0.062	No measurement						
	5	0.825	1.0	0.248	40305	0.822	0.95	0.20	0.248	2.28	10
Transonic	z3	0.850	1.5	0	-	0.850	1.5	0	0	2.39	11
	6	0.850	1.0	0.060	40906	0.853	1.10	0.16	0.060	2.40	12
	7	0.850	1.0	0.240	40806	0.854	1.05	0.02	0.240	2.41	13
	z4	0.875	1.5	0	-	0.875	1.5	0	0	2.43	14
	8*	0.875	1.0	0.059	40907	0.877	1.13	0.15	0.059	2.43	15
	9*	0.875	2.0	0.059	No measurement						
	10*	0.875	1.0	0.234	40807	0.879	1.08	0.01	0.234	2.44	16
	z5	0.960	1.5	0	-	0.960	1.5	0	0	2.51	17
	11	0.960	1.0	0.054	40911	0.960	1.03	0.00	0.54	2.53	18
	12	0.960	1.0	0.214	No measurement		0.18				

Comments on Table 4: Cases z1 to z5 are extra to the computational cases identified in reference 8. They correspond to zero-frequency (k=0) experimental data that are closely related to the CT cases for which $k \neq 0$. The asterisks denote priority cases. In all cases $\alpha_m = 0$. Transition is fixed at 0.15c.

Table 5

M=0.800	F =0	ALPHA=0.00	KC=1.32
		DELTA=0.00	MC=.612
		C = 1.5	NC=.0372

	UPPERSIDE				LOWERSIDE			
X/C	CP+	M+	DCP+		CP-	M-	DCP-	
			RE	IM			RE	IM
.010	-.005	.802	3.552	0.0	.029	.787	-3.609	0.0
.050	-.154	.870	2.292	0.0	-.143	.865	-2.253	0.0
.100	-.192	.887	1.833	0.0	-.179	.881	-1.833	0.0
.200	-.236	.907	1.680	0.0	-.238	.908	-1.719	0.0
.300	-.268	.922	1.719	0.0	-.273	.924	-1.852	0.0
.400	-.290	.932	1.890	0.0	-.293	.933	-2.005	0.0
.450	-.276	.926	1.967	0.0	-.267	.921	-1.986	0.0
.500	-.249	.913	1.890	0.0	-.250	.914	-2.024	0.0
.550	-.216	.898	1.948	0.0	-.213	.897	-1.986	0.0
.600	-.179	.881	2.005	0.0	-.176	.880	-2.158	0.0
.650	-.150	.868	2.215	0.0	-.144	.865	-2.349	0.0
.700	-.119	.854	2.597	0.0	-.103	.847	-2.616	0.0
.725	-.104	.847	2.941	0.0	-.084	.838	-2.826	0.0
.750	-.096	.843	4.431	0.0	.007	.797	-7.086	0.0
.775	-.071	.832	3.858	0.0	-.053	.824	-3.724	0.0
.800	-.046	.821	2.807	0.0	-.034	.815	-2.769	0.0
.850	-.010	.805	1.661	0.0	-.004	.802	-1.699	0.0
.900	.023	.790	.974	0.0	.030	.786	-.974	0.0
.950	.067	.770	.458	0.0	.072	.768	-.477	0.0

Table 6

RUNNO 40904						
M=0.794		F=30.00		ALPHA=0		
P0=10429				DELTA=.15		
RE=1.04E+04		K=.064		C=1.09		
Q=3037.30						
	RE	IM		RE	IM	
KC=	1.016	-0.26	RC=	.2766	.0112	X5=1.334E-03 1
MC=	.640	.010	NC=	.0385	.0028	X6=1.346E-03 0

			UPPERSIDE						LOWERSIDE			
X/C	CP+	M+	DCP+		DCP+		CP-	M-	DCP-		DCP-	
			RE	IM	MOD	ARG			RE	IM	MOD	ARG
.010	-0.035	.811	.671	-1.474	1.619	-65	.077	.759	-0.736	1.554	1.719	115
.050	-0.175	.873	.342	-0.753	.827	-66	-0.120	.847	-0.678	1.050	1.250	123
.100	-0.226	.897	.657	-0.853	1.077	-52	-0.166	.867	-0.737	0.895	1.159	129
.200	-0.252	.909	.991	-0.787	1.266	-38	-0.222	.893	-1.115	0.826	1.387	143
.300	-0.279	.921	1.245	-0.683	1.420	-29	-0.256	.908	-1.276	0.708	1.459	151
.400	-0.304	.932	1.628	-0.554	1.719	-19	-0.279	.919	-1.578	0.605	1.690	159
.450	-0.287	.925	1.744	-0.403	1.790	-13	-0.260	.910	-1.665	0.490	1.736	164
.500	-0.263	.914	1.826	-0.301	1.850	-9	-0.235	.898	-1.825	0.379	1.864	168
.550	-0.222	.895	1.915	-0.198	1.925	-6	-0.199	.882	-1.927	0.288	1.948	172
.600	-0.190	.881	2.034	-0.113	2.038	-3	-0.165	.867	-2.105	0.185	2.113	175
.650	-0.159	.866	2.155	-0.136	2.159	-4	-0.127	.850	-2.302	0.118	2.305	177
.700	-0.125	.851	2.258	-0.253	2.272	-6	-0.089	.833	-2.649	0.043	2.650	179
.725	-0.108	.844	2.658	-0.213	2.667	-5	-0.071	.825	-2.885	0.023	2.885	180
.750	-0.068	.825	4.948	.409	4.965	5	.013	.787	-5.276	1.571	5.505	163
.775	-0.085	.833	4.097	.224	4.103	3	-0.030	.806	-3.821	-0.047	3.822	181
.800	-0.058	.821	3.038	.335	3.057	6	-0.018	.801	-2.943	-0.141	2.946	183
.850	-0.018	.803	1.751	.212	1.764	7	0.006	.790	-1.738	-0.042	1.739	181
.900	.021	.786	.959	.100	.964	6	0.038	.776	-1.066	-0.090	1.069	185
.950	.069	.764	.374	.013	.374	2	.080	.757	-0.501	-0.043	.503	185

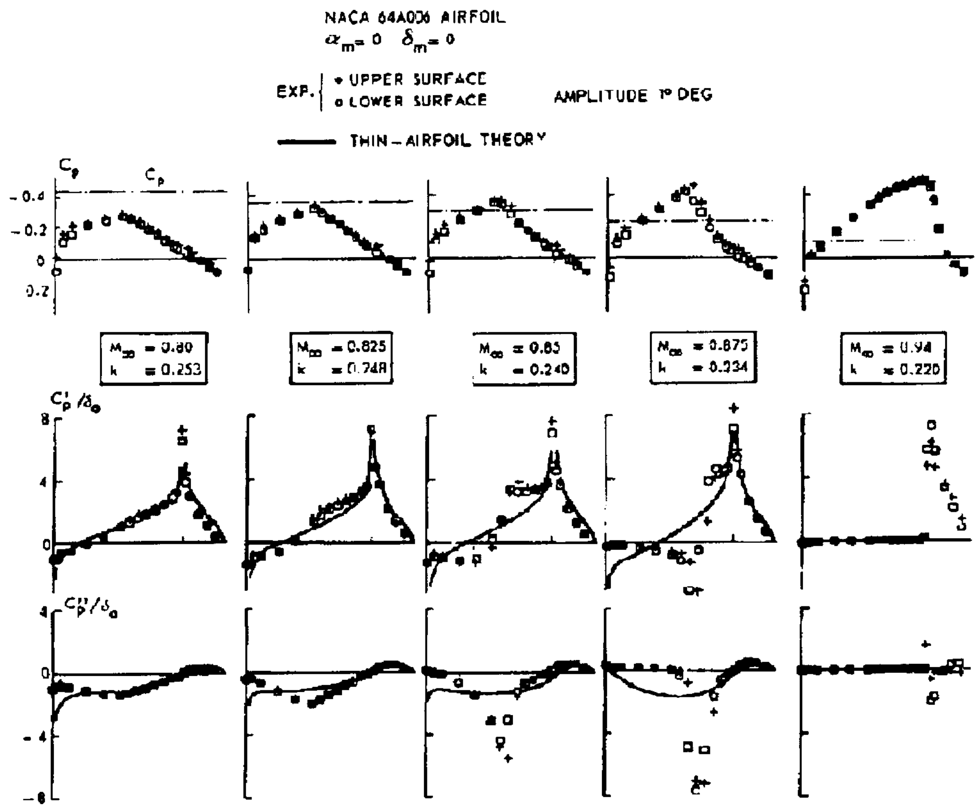


Fig. 1 Development of mean steady and unsteady pressure distributions with Mach number (f = 120 Hz)

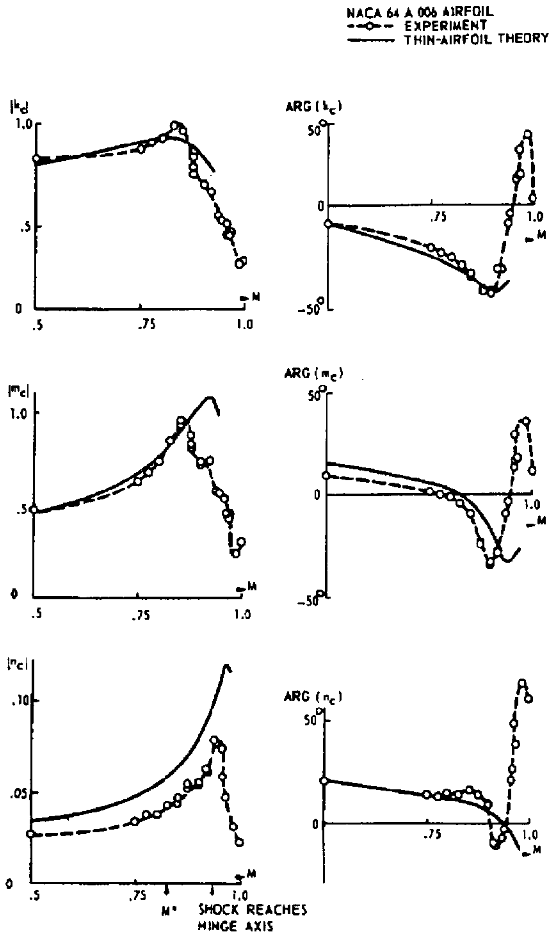


Fig. 2 Unsteady aerodynamic coefficients as a function of Mach number (f = 120 Hz)

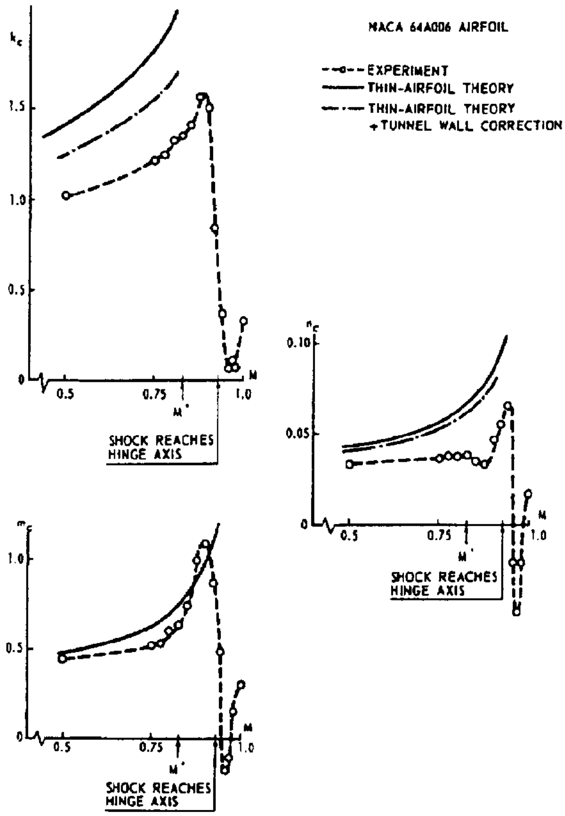


Fig. 3 Steady aerodynamic derivatives as a function of Mach number

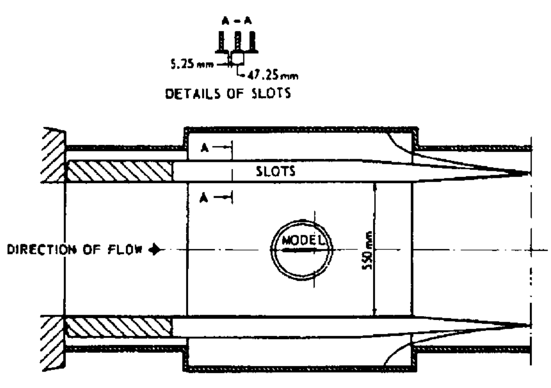


Fig. 4 Transonic test section of the NLR Pilot Tunnel

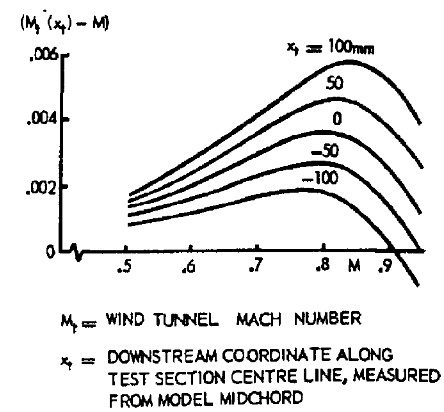


Fig. 5 Mach number distribution in NLR Pilot Tunnel test section

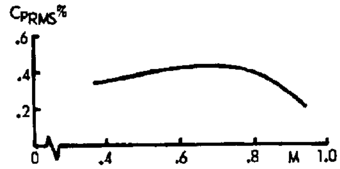


Fig. 6 Noise level in NLR Pilot Tunnel test section

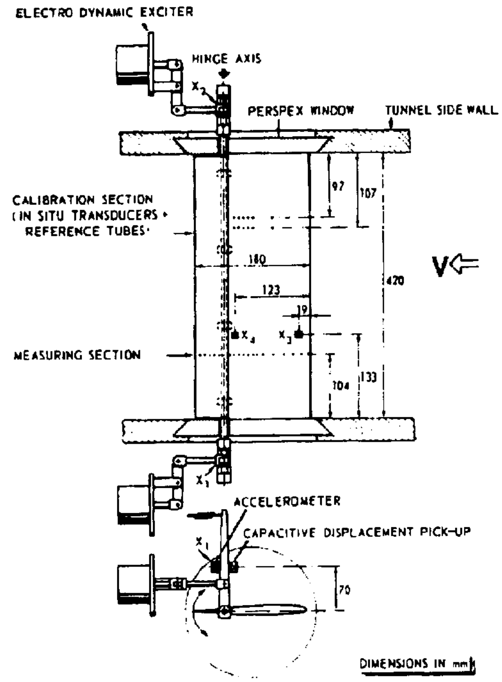
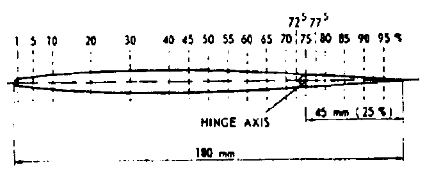


Fig. 7 Test set-up and instrumentation of the NACA 64A006 airfoil with flap



MEASURING SECTION (BOTH UPPER AND LOWER SURFACE)			
No.	x/c	No.	x/c
1	.01	11	.65
2	.05	12	.70
3	.10	13	.725
4	.20	14	.75
5	.30	15	.775
6	.40	16	.80
7	.45	17	.85
8	.50	18	.90
9	.55	19	.95
10	.60		

CALIBRATION SECTION (UPPER SURFACE ONLY)	
No.	x/c
1	.30
2	.50
3	.55
4	.60
5	.65
6	.70

Fig. 8 Location of pressure orifices on the NACA 64A006 airfoil with flap

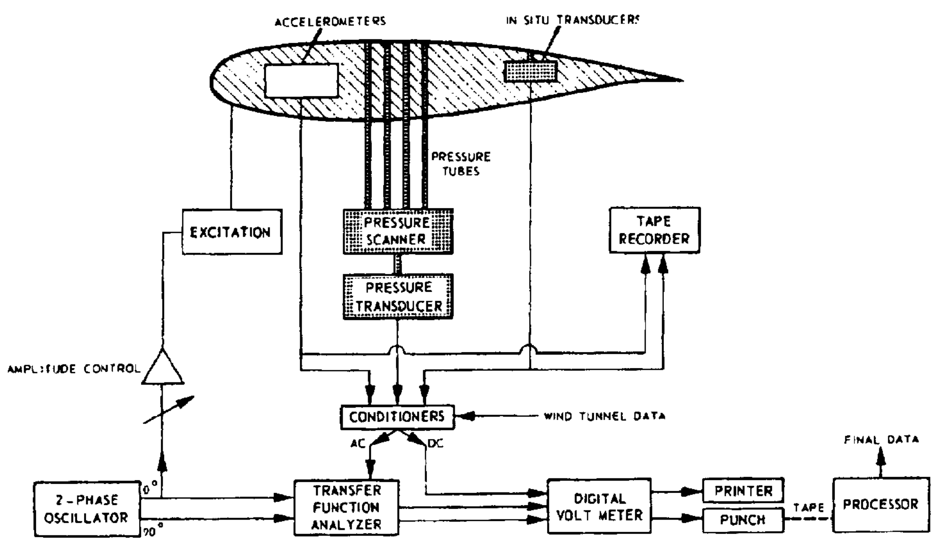


Fig. 9 Block diagram of measuring equipment